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ELECTRICAL SCIENCE AT THE BRITISH ASSOCIATION.

THE TELEPHONE.

By W. H. PREECE, M.I.C.E.

IN the year 1837, Page, an American physicist, discovered that the rapid magnetisation and demagnetisation of iron bars produced what he called "galvanic music." Musical notes depend upon the number of vibrations imparted to the air per second. If these exceed 16, we obtain distinct notes. Hence, if the currents passing through an electro-magnet be made and broken more than 16 times per second, we obtain "galvanic music," by the vibrations which the iron bar imparts to the air. The iron bar itself imparts these vibrations by its change of form each time it is magnetised or demagnetised.

De la Rive, of Geneva, in 1843, increased these musical effects by operating on long stretched wires, which passed through open bobbins of insulated wire.

Philip Reis, of Freidrickdorf, in 1861, produced the first telephone which reproduced musical sounds at a distance. He utilised the discovery of Page by causing a vibrating diaphragm to rapidly make and break a galvanic circuit. The principle of his apparatus is as follows: There is a hollow wooden box into which the operator sings through a mouthpiece. The sound of his voice throws a diaphragm into rapid vibration, so as to make and break contact at platinum points at each vibration. This interrupts the current flowing from a battery as often as the diaphragm vibrates, and magnetises and demagnetises an electro-magnet as often. Hence, whatever note be sounded into the box, the diaphragm will vibrate to that note, and the electro-magnet will similarly respond, and therefore repeat that note. Musical sounds vary in *tone*, in *intensity*, and in *quality*. The *tone* depends on the number of vibrations per second only, the *intensity* on the amplitude or extent of these vibrations; the *quality* on the form of the waves made by the vibrating particles of air.

It is evident that in Reis' telephone, everything at the receiving end remained the same excepting the number of vibrations, and therefore the sounds emitted by it varied only in tone, and were therefore notes, and nothing more. The instrument remained a pretty philosophical toy, and was of no practical value.

Cromwell Varley, in 1870, showed how sounds could be produced by rapidly charging and discharging a conductor.

Elisha Gray, of Chicago, in 1873, succeeded in producing tones from the finger when rubbing a dry sonorous body, such as an ordinary tin can, while the intermittent currents sent by a vibrating tuning fork were passing through it, and by attaching an electro-magnet to a hollow sounding box, open at one end and closed at the other, he was able to reproduce exactly the *tones* of the musical notes transmitted. His electro-magnet had its armature rigidly fixed to one pole, and separated from the other by a space of one-sixtieth of an inch. He called it a *resonator*. The vibrations of this armature were imparted to the sounding box, and became thereby magnified. He constructed a key-board of two octaves compass, with steel reeds, each of which was tuned to its proper note and maintained in vibration by electro-magnets. When the key corresponding to any note was depressed, its corresponding reed was connected to line, and the proper number of currents transmitted to the distant station, where they operated the resonator, and there reproduced the note. In this way tunes were played, and the instrument became an electric organ. By attaching organ pipes to his resonator he magnified the sounds, and was able to fill a large hall with music played at places from 90 to 280 miles away. More than that he proved the practicability of transmitting chords and composite sounds to distant places.

Gray also invented a method by which the intensity of the note as well as their tones could be transmitted, but it remained for Prof. Graham Bell, of Boston, who has been working at this question with the true spirit of a philosopher since 1872 to make the discovery by which tone, intensity, and quality of sounds can all be sent. He has rendered it possible to reproduce the human voice with all its modulations at distant points. I have spoken with a person at various distances up to thirty-two miles, and through about a quarter of a mile have heard Prof. Bell breathe, laugh, sneeze, cough, and —in fact, make any sound the human voice can produce. Without explaining the various stages through which his apparatus has passed, it will be sufficient to explain it in its present form. Like Reis he throws a diaphragm into vibration, but Prof. Bell's diaphragm is a disc of thin iron which vibrates in front of a soft iron core attached to the pole of a permanent bar-magnet. This core becomes magnetised by the influence of a bar-magnet, inducing all around it a *magnetic field*, and attracting the iron diaphragm towards it. Around this core is wound a small coil of No. 38 silk-covered copper wire. One end of this wire is attached to the line wire, the other is connected to the earth. The apparatus at each end is identically similar, so that it becomes alternately *transmitter* and *receiver*—first, being put to the mouth to receive sounds, and then to the ear to impart them. Now the operation of this apparatus depends upon the simple fact that any motion of the diaphragm alters the condition of the magnetic field surrounding the core, by strengthening or weakening it, and any alteration of the magnetic field—that is, either its strengthening or weakening—means the induction of a current of electricity in the coil. Moreover the strength of this induced current depends upon the amplitude of the vibration, and its form on the rate of vibration. The number of currents sent of course depends upon the number of vibrations of the diaphragm. Now each current induced in the coil at one end of the line passes through the line wire to the coil at the other end of the line, and there it alters the magnetisation of the core, increasing or diminishing its attraction for the iron diaphragm. Hence the diaphragm is vibrated also, and every vibration of the one dia-

phragm must be repeated on the other diaphragm with a strength and form that must vary exactly together. Consequently, whatever sound produces the vibration of one diaphragm is repeated in the other, because its vibrations are an exact repetition of the former.

It is quite evident, however, that Bell's telephone is limited in its range. The currents operating it are very weak, and it is so sensitive to currents that when attached to a wire which passes in the neighbourhood of other wires, it is subject to be acted upon by every current that passes through any one of these wires. Hence, on a busy line, it emits sounds that are very like the pattering of hail against a window, and which are sometimes so loud as to overpower the effects of the human voice.

Now Mr. T. A. Edison, of New York, has endeavoured to remedy these defects in Bell's Telephone by introducing a transmitter which is operated by battery currents whose strengths are made to vary directly with the quantity and intensity of the human voice. In carrying out his investigations in this field he has discovered the curious fact that the resistance of plumbago varies, in some ratio inversely proportional to the pressure brought to bear upon it. Starting from Reis' transmitter he simply substitutes for the platinum point a small cylinder of plumbago, and he finds that the resistance of this cylinder varies sufficiently, with the pressure of the vibration of the diaphragm, to cause the currents transmitted by it to vary in form and strength to reproduce all the varieties of the human voice. His receiver also is novel and peculiar. In 1874 he discovered that the friction between a platinum point and moist chemically-prepared paper varied every time a current was passed between the two, so that the rate with which the paper moved was altered at will. Now, by attaching to a resonator a spring whose platinum face rested on the chemically-prepared paper whenever the drum was rotated, and currents sent through the paper, the friction between the spring and paper is so modified that vibrations are produced in the resonator, and these vibrations are an exact reproduction of those given out by the transmitter at the other station.

Edison's telephone, though not in practical use in America, is under trial. In some experiments made with it songs and words were distinctly heard through 12,000 ohms, equal to a distance of 1000 miles of wire.

Bell's telephone is, however, in practical use in Boston, Providence, and New York. There are several private lines that use it in Boston, and several more are under construction. I tried two of them; and though we succeeded in conversing, the result was not so satisfactory as experiment led one to anticipate. The interference of working wires will seriously retard the employment of this apparatus, but there is no doubt that scientific inquiry and patient skill will rapidly eliminate all practical defects.

THE EFFECT OF TRANSVERSE STRESS ON THE MAGNETIC SUSCEPTIBILITY OF IRON.

By Sir W. THOMSON.

THE paper described the results of experiments made by Messrs. Andrew and Thomas Gray, by aid of a Government grant of £100. These proved that the effect of transverse stress was to diminish magnetisation, while the strength of the magnetising current was below a certain value, and to increase it when the current was above that value.

MAGNETIC INDUCTION, AS AFFECTING OBSERVATIONS OF THE INTENSITY OF THE HORIZONTAL COMPONENT OF THE EARTH'S MAGNETIC FORCE.

By C. CHAMBERS.

THE conclusion arrived at in this paper was that the correction hitherto made for induction was unnecessary; and Sir W. Thomson observed that his rigorous investigations had removed what was a very great stumbling-block in observations of the kind, as he had showed that the supposed necessity for the correction was altogether a mistake.

THE DISCOVERY OF THE TELEPHONE.

By PROF. GRAHAM BELL.

AFTER the lectures which have been delivered by Mr. W. H. Preece on the electric telephone, it is scarcely necessary for me to describe either the construction of the invention in its present form, or the mode of operation. It will, perhaps, be more interesting if I take the matter up in another light, and explain what I may designate evolution of the telephone—the process by which it has been brought to its present state. Many years ago my attention was directed to the vibrations occasioned in the air by vocal utterances. Probably only a few of you have noticed the interesting subject. I am speaking to you now, you hear me, and the thing "sound" exists in the air, between my mouth and your ears. When you come to investigate what the "thing" is, you will find that it consists of a vibratory movement of the air. At all events it is a movement of the air, and it is this movement of the air which causes audition. All that is necessary in order to produce any sound is to move the air in the same way as it is moved by vocal utterances. I do not know how it occurred to me to use electricity as a means of conveying vibration from one place to another, but the idea was certainly in my mind several years ago. I thought that if I could cause the intensity of an electrical current to vary in exactly the same proportion as the density of the air varied in the production of sound, a step would be accomplished in the right direction. In the course of my experiments it struck me that a completely flat membrane would not perfectly copy the motion of the air, and I considered it possible to make use of a concave membrane in the shape of an ear. I was convinced that in this way, somehow or the other, the vibratory movements could be effectually copied. I consulted Dr. Clarence Blake relative to the mechanism of the human ear, and the doctor asked me why I did not try the human ear itself. This came upon me as a new notion, and on Dr. Blake obtaining an ear for me from a dead subject I made experiments upon it. In speaking to the ear I observed vibrations, and I was forcibly struck with the great disproportion between the mass of the bones, and the membrane by which they were set in vibration. The membrane was very small, and thinner, or as thin, as tissue paper, while the bones were solid and massive, and I felt that if the membrane could set the bones in vibration it might be possible to produce similar results by an

apparatus made after the same fashion. I, therefore, constructed an apparatus on the model of the human ear, and I assumed that if I placed another apparatus of the same character at the other end of a telegraph wire the sound of the human voice might be transmitted by means of the electric current. I accordingly placed one instrument at the top of the house, and another at the bottom; I sang loudly into the mouthpiece, and my assistant afterwards told me he thought he heard a faint sound. I was unable, however, to discover any sound myself. I constructed another instrument of iron, but not quite so heavy. This instrument also failed, but I was convinced that the failure was not attributable to the principle so much as to the nature of the article used. I made still another instrument, and in the result heard articulate sounds. Although the articulation was not distinct, I now became confirmed in my convictions that the principle I was acting upon was right. I thought of inserting a very small and light piece of iron or steel into the membrane, and then, singing into the instrument at one end, the tones of the voice were clearly audible at the other. I sent a friend to the other end to notice the effect produced by articulate speech. Having spoken through, I asked if my friend could understand what had been said, and immediately the answer came through the instrument itself, "Yes, I understand you perfectly." This was probably the first sentence that had been clearly understood without there being any foreknowledge as to what was so be said. This showed me that I was on the right track. When a pre-arranged sentence was transmitted it could be understood very well, but with an unknown sentence there was difficulty. Certain of the vowel sounds were transmitted pretty well, but the consonants were not so successful. The forms of apparatus used have been multitudinous. It was at this stage of my researches that the instruments were exhibited at the Centennial Exhibition in Philadelphia last year, and Sir William Thomson obtained one of them, and showed it at the last meeting of the British Association. Being certain in my own mind that full and distinct articulation could be obtained, I systematised my experiments somewhat. This system led me onward, and I looked forward to still greater changes in the instrument. After Sir William Thomson left America I determined to vary every part of the telephone, and observe the effect. In that manner I hoped to discover the capacity and power of each portion of the telephone, and so construct one which would produce perfect results. I found that on enlarging the circular disc of iron attached to the membrane the sounds emitted from the other end were more distinct and lucid. Soon afterwards I was able to carry on a conversation with my associate. We then experimented with a telegraph wire, the ends of which were two miles apart, and we carried on a conversation without much difficulty. So extraordinary were the effects that, although I began by thinking I knew something about the telephone, I came to the conclusion it was nothing of the kind. I now considered the vibration was molecular, although originally I had inclined to the belief that it was membranous. I had four different kinds of apparatus, and was uncertain which was best, but experiments are being conducted at the present time for the purpose of making improvements and developments. It might thus be said that the telephone has been evolved from a consideration of the mechanism of the human ear. What the ultimate form of apparatus may be I do not know. I do not bring this before you as a perfected invention, as it is only in an embryo state, but I hope that by the next meeting of the Association a still better form of apparatus will be devised. I feel bound to acknowledge my indebtedness to many scientific friends in America for the assistance they have rendered me. Professor Pearce, of Brown University, and others, have been working at the telephone, and whenever any new idea occurred to them they communicated it to me, and so assisted me in the development of the invention. I am indebted to them, indeed, for the form the apparatus now assumes.

In the telephonic organ which I have brought from America the only novelty is that the music is produced electrically. It is an ordinary parlour organ, the reeds being all connected with a battery. When a reed is blown with wind it vibrates against a point, so that when contact occurs a current of electricity traverses the telegraph wire, and comes through the telephone.

It has been stated that a full concert has been heard through the telephone; this is not the case, nor do I believe it possible in the present state of the telephone. What might be possible in the future no man can predict. This much is true, however, that a telephone has been placed in the midst of a brass band, the wire from the telephone passing to my laboratory. In listening I heard the men tuning up their instruments, and finally I could distinguish the playing of the full band, only the notes were out of proportion, the lower notes being the louder. I telephoned the leader of the band, and requested him to place the higher cornets nearer the instrument, and then I was enabled to hear the full harmony of the brass band, about two feet from the telephone. It was true that a speaker or singer could be recognised by his voice. I could at once recognise the voice of a friend after he had become accustomed to the particular modifying influence of the telephone on the voice—at least, where the articulation was marked.

The Mode of Stating some Elementary Facts in Electricity.

By Prof. FOSTER, F.R.S.

Commenting on this paper, Lord Rayleigh observed that there was a great deal of confusion not only in the elementary books but in the minds of scientific men as to the way in which electrical problems might be stated, and their President had done service to beginners and those more advanced, showing how different ways of stating a case might be harmonised.

An Improved Lantern Galvanoscope.

By S. P. THOMSON.

This instrument, the invention of Mr. S. P. Thomson, consists of a galvanometer fitted into a magic lantern, and enables a lecturer to exhibit to an audience of any size the working of the galvanometer needle. It has been tried with a thermopile with satisfactory results, and shows very fairly the

heat of the hand. Sir. W. Thomson spoke of this as a most valuable instrument, and said that whenever he had occasion in future to explain magnetic phenomena to a large audience, he should certainly avail himself of Mr. Thomson's beautiful arrangement.

ELECTRIC BLOCK TELEGRAPHS.

By F. B. VARLEY.

RAILWAY companies invariably adopt the systems recommended by their respective superintendents. Two distinctive methods are in vogue, namely, permanent and intermittent current signalling. The instrument I have invented belongs to the second order, and I believe that if it were generally adopted the risk of accident from defective signalling would be reduced to a minimum. There is a reversible tablet, and when a signal from a distant station has been acknowledged both the indicating needle and the sending tablet are in the same position. When the needle has once been deflected its position cannot be altered, so that if the tablet is at block, and the signal sent has been acknowledged, the two needles and the two tablets are at block.

AN IMPROVED DOUBLE CURRENT KEY.

By P. TRIMMER, of the *Persian Gulf Telegraph*.

FIG. 1 gives an elevation, and fig. 2 a plan of the connections of this key.

FIG. 1.

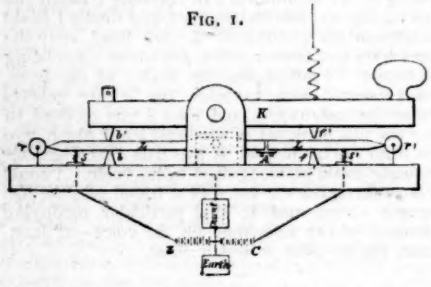
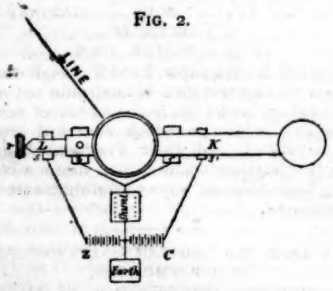


FIG. 2.



In Fig. 1, K is an ordinary Morse key. L is a brass beam, the two halves of which are insulated from each other at A. This beam works on an axle (shown by the dotted lines) beneath K, from which it is insulated, and plays between the back and front stops *b b'* and *f f'*; it is maintained in whatever position it may be last thrown by the action of K, by the rollers *r* and *r'*. These two rollers work on springs which are so adjusted that when the beam L is in the position of rest, as shewn in Fig. 1, *r* tends to press it downwards, and *r'* upwards. This order of things is reversed when K is depressed, as *r'* then presses L downwards and *r* presses it upwards. *s* and *s'* are two weak spiral springs by means of which the negative and positive poles of two batteries are maintained in connection with the back and front halves of L respectively. They exercise no influence over the movements of L.

The back and front stops *b* and *f* are permanently in connection,, and are to earth through the adjustable resistance marked "Shunt."

The action of the key is as follows :—Fig. 1 shews the key at rest. The switch (not shown in the diagram) being turned to "send," the negative current passes on to the beam L at *s*, and at the stop *b* it divides between the shunt and line; if now K be depressed, L does not follow its movements immediately, being held in position by the spring *s*, but finally it is struck against by *f'*, at which moment the full positive current passes to line, and then L being pressed down until the stop *f* is reached, the shunt comes into play carrying off a portion of the current. The negative half of L has at the same time been raised from contact with the back stop *b*, and now occupies the same position with respect to *b* and *b'* as the positive half had previously occupied with regard to *f* and *f'*—viz., touching neither. If now K is allowed to fall back similar movements takes place; first, the full negative current is sent to line at the moment L is struck, which continues until the position of rest is regained, and then the reduced current flows. This arrangement has been worked satisfactorily through 500 miles of cable from Kurrachee to Jask, but from the incomplete nature of the apparatus no reliable comparison as regards speed with the ordinary "permanent" current keys have been obtained.

INDIA-RUBBER CONSIDERED IN REFERENCE TO ITS APPLICATION TO TELEGRAPHY.

By THOMAS T. P. BRUCE WARREN,

Analytical Chemist to the India-rubber, Gutta-percha, and Telegraph Works Company, Limited.

(*Continued from page* 189.)

BESIDES the application of india-rubber as an insulator for submarine cable cores, ærial and land wires, there are many other purposes for which it is used in connection with telegraphy, and principally in its harder forms of vulcanisation which are known as ebonite or vulcanite.

Ebonite is now extensively used for battery cells, and for insulating supports. In fact it is now so universally employed by the electrician that there is scarcely a piece of apparatus in which it is not employed.

Formely it was much used for pole insulators, and covering "pins" for their support. Its use, however, for these purposes has been abandoned to a very great extent, owing to its surface becoming

cracked and roughened by the weather which destroyed their insulating properties.

At one time it was the practice to varnish these insulators and pins with a varnish consisting of naphtha and asphalt, and I am more inclined to think that the bad repute into which they have fallen for line work is in a great measure due to the attraction of dirt, &c., by this varnish, for an unvarnished and clean turned insulator will retain its insulating properties for a long time, the surface will neither become coated with a film of sulphurous acid so readily as if left rough, nor crack on the surface.

The testing of insulators and pins will be included in a subsequent paper on testing.

Mr. Hooper has given considerable attention to the coating of telegraph wires under his patent, with this harder form of vulcanised rubber, and there can be no doubt that the discovery of a flexible form of vulcanite for this purpose is one of the most important matters in connection with india-rubber insulation with which manufacturers can occupy themselves.

The time may probably arrive when deep sea cables will no longer have the present mode of protection by iron and hemp, in which case a tough and resilient insulator will become a desideratum.

The objection to vulcanite for this purpose, at present, is that, if a length of insulated wire be left for a short time coiled up, it retains its form so rigidly that by uncoiling it is very liable to crack.

Vulcanite is itself a splendid insulator, possesses great hardness, and is not distorted when a heavy weight is placed upon it. It is of all insulating substances (except glass), the highest non-absorbent for water. I have not yet seen any method worthy of being called a jointing process by which it can be united.

This last objection is entirely removed in the hard form of india-rubber obtained by the action of iodine and bromine.

I propose on a future occasion to deal more fully with some of the causes which have contributed to the decay of india-rubber cores, and to describe the methods employed for applying india-rubber to the different cable cores which have been manufactured. This will enable us to examine, specially, the electrical and mechanical data which must tend to remove any idea that has existed, that because india-rubber cores have a lower inductive capacity than gutta-percha cores, we may economise in the bulk of submarine cores.

This has been a most disastrous mistake, and requires the attention alike of engineers and manufacturers.

I shall devote the remaining portion of this chapter to the consideration of faults in india-rubber cores. A very singular description of fault is met with in vulcanised or semi-vulcanised india-rubber cores which was first pointed out, I believe, by Mr. C. L. Madsen during the sheathing of the core for the Anglo-Danish Cable, at the works of Mr. R. S. Newall.

If a piece of vulcanised india-rubber core is forcibly struck or squeezed, it will appear, unless carefully inspected, quite sound and free from any distortion, which of course results from its elasticity. If tested in water it will be found otherwise; by carefully removing the felt or tape covering, a clean slit will be found in it as if cut by a knife, and in the core itself a slit corresponding to it; if the blow has been very severe this cut will extend to the conductor, and on the other side of the core a hole or slit smaller in size and shorter in length will also be found to have been produced.

Such faults could be easily produced in a cable machine by a bobbin of heavy wire, allowing its wire to run off too fast so as to allow its slack to strike the core. On this account when india-rubber cores are required for heavy shore ends it is safer to protect the core first in the form of making it into a light iron protected cable.

I have seen several hundred miles of heavy shore ends covered up in this way without a single mishap, whereas a short length covered up with a sheathing of three stranded iron wires direct on the jute serving showed a serious fall in its insulation after being covered up a short time. The shore end of a cable laid in the West Indies for the Cuba Submarine Company, which consisted of a heavy iron sheathing directly over the serving contained a similar fault, which was only discovered a few days before paying out.

That such faults occur during the sheathing is shewn by the perforation of the tape covering of the core which is put on after the insulating covering is finished.

Sometimes a core may be in water several days with such a fault in it, without even appearing suspicious when tested, but gradually break down if left in the water. Now, on inspecting this fault it will not unfrequently be found that a good sized slit extends through the core down to the conductor. Mr. R. Sabine has given a very good explanation for this behaviour of a fault: he says, that the inner portion of the rubber not being vulcanised, the recently cut edges unite again, which temporarily conceals the fault, and the imperfect union thus produced is only sufficient to prevent the ingress of water for a short time. This explanation is competent to deal with every indication of such a fault.

There now and then crops up a species of fault which I have never been able to account for; fortunately its rarity has limited our knowledge of them. They appear more frequently than otherwise when the core is made into cable, and are so minute that their actual locality can only be found by strongly charging from an electrical machine, the surface of the core being well cleaned and dried, so that on presenting a rounded conducting body, a spark is seen to pass through the hole to it. This method of "spotting" a very small fault was suggested to the author by Mr. J. C. Laws some few years ago, and is highly serviceable to detect the actual spot in which a very small defect exists.

Whatever may be the cause of such faults, it is certain that these holes contain some highly conducting substance, their low resistance is scarcely accounted for on the supposition that water alone is the conducting medium. Probably a thin and fine shaving of copper, or a fragment of unoxidized lead, or a little of the "puce oxide" of lead may cause such a fault. The removal of some foreign substance by solution from the coatings, or the action of a fine cotton fibre communicating through to the water, are causes too remote in their probability to be considered as giving rise to them. It is not easy to conceive that air or gas can produce such faults,

These are called from their similarity to small punctured holes, "pin holes."

In all the forms of insulating with india-rubber, where direct contact between the conductor and the insulator has not been provided against by varnishing or covering with cotton, the conductors are covered with tin, or a mixture of tin and lead. At one time a more easily fusible alloy was employed, by the addition of a small quantity of bismuth. This alloy allowed the tinning process to be conducted at a much lower temperature than could be effected without bismuth, which no doubt arose from the lower melting point of the alloy. It was thought that the application of the higher temperature required to melt tin and lead would tend to alter the mechanical qualities of the copper. Although the bismuth alloy allowed the use of a lower temperature, it was considered that whatever advantages were due to this, it was more than counterbalanced by the high cost of bismuth, and the coating itself adhering less tenaciously to the copper than the mixture of the metals in which it was omitted. The copper wire, too, became slightly more brittle after some time, whilst the metallic coating itself after the wires were vulcanised was more strongly attacked.

It is usual now to employ tin with as little lead as possible, from the energy with which sulphur attacks this latter metal. The lead when added, is with a view of obtaining a more easily fusible alloy, thus avoiding too much heating of the copper. The advantage arising from this is so questionable, that I cannot see why tin alone should not be used.

There cannot be the slightest doubt but that the strength of copper wire is damaged in some part of this tinning process. Several instances have lately been brought to the notice of the writer, where tinned copper wire, insulated with the semi-vulcanised form of india-rubber, has become seriously brittle. Space will not allow my dealing at present with the chemical aspect of this question.

Until this can be satisfactorily avoided, it cannot but be regarded as a great risk to employ such wire for deep sea cables, although it is possible to lay such an india-rubber covered wire, the recovery for repairing is, from past experience, a very uncertain and unpleasant task.

A short time ago a cable which was laid in 1,600 fathoms of water, was found to offer a "copper resistance" of nearly a megohm. The determination of the position of the fault was a very tedious operation, and eventually the spot was fixed upon as being about the middle of the cable. After the removal of the fault, which was due to a slight file cut produced in making a joint, and obtaining answers to our signals from the ship, another loss of signals occurred, which was found to be due to another break of the conductor in the length of cable picked up. This was removed, and the pieces prepared for splicing up again, when from another break being found in the recovered portion, it was decided to be more prudent to abandon its use.

This singular behaviour of copper wire is one of the most important facts in connection with india-rubber insulation, for the breakages which happened after the removal of the principal fault, had no appearance of being cut or damaged. The same kind of fault has been recently found to be produced by much less severe handling than the hauling in from this depth would necessitate.

The deep sea cables from which these faults were removed was after the Atlantic pattern, whilst the others have appeared in a light form of hemp covered cable, without iron, for torpedoes.

The liability of an imperfectly protected india-rubber core to develop these embarrassing faults calls for immediate inquiry, for if india-rubber is to become adopted for deep sea cables, it is certain that no form of outer covering, unless of the most rigid description, so long as its flexibility for handling in coiling, &c., be not lost sight of, can with any certainty of success be adopted.

Although I am not certain as to how this description of fault is provided, I may hazard a suggestion in the hope, that if a more competent one can be made, some of our readers will assist us with their ideas, for it seems a great pity that just as india-rubber is asserting itself as an insulator worthy of consideration for deep sea cables, that we should be compelled to pause, not from any electrical question as to its character, but the mechanical means of its protection.

The accompanying figure is drawn to represent the full size of one of the faults referred to, with the insulator cut away to show the distorted condition and break of the conductor.

The most remarkable feature in this fault is the perfectly clean incision of the conductor, the whole of the wires forming the strand being divided as if cut with a pair of pliers. Were it not for the sharp knuckling in the both portions of the conductor on the opposite sides of the break, it would not be so easy to account for it. Experiments made with vulcanised rubber cores under strain, show that perfect insulation is retained by the core, even when the strain has been so great as to rupture the conductor, and it has been further observed that the ends of the conductor may be drawn a foot or more away from each other, which, on releasing the strain, again approaeh each other so as to give a very fair amount of conduction.

I have frequently met with cases of "no continuity" suddenly disappear, resulting with resistances in the conductor as if absolutely sound; when the only way in which it could be found for removal has been to keep the core joined up for a continuity or resistance test, and keeping a watch on a galvanometer until a change is indicated, whilst the core is being tightly drawn through the hands, or over and around pulleys.

Clearly, an induction test would be of no use for finding the position of such a fault, and even if the ends are retained some little distance apart, continuity will appear from the fact that a portion of the alloy detached from the copper forms a metallic coating or "stain," on the insulator, or a coating of sulphide of copper will, if much sulphur is present, be found lining the inside surface of the insulator.

When the conductor is found broken in this way, the ends at the break are generally a little harder and finer than the unbroken parts, and these appearances are also met with in the faults under consideration. So that we may fairly assume that they are produced by straining, and as soon as the strain is removed the very elastic nature of the insulator

tends to make the core regain its former length; but the copper being permanently elongated, the ends being forced against each other, it is compelled to knuckle out in the manner shown. I have seen this fault more frequently with small conductors than in larger ones, but have seen no case where the core has been protected with close iron wires as in that type of cable usually known as "intermediate deep sea."

With this unfortunate exception, it must be admitted that what has to be recorded in the history of india-rubber for deep sea cables, compares most favourably with anything which has been achieved with gutta-percha.

A cable made by Hooper's Telegraph Works Limited, is probably submerged in deeper water than any other cable at present in existence, and its paying out was so far successful that it is, to my mind, one of the greatest successes in deep sea telegraphy. The core was of small dimensions, the conductor being a strand of seven wires, weighing about 160 lb. per nautical mile. The construction of the cable appears to be the best form suited for this material.

The future behaviour of this cable must be highly interesting to every one who wishes a disinterested welfare to telegraphy. For years it was a general cry that no india-rubber cable could be pointed to as being laid in deep water; this objection, like most others, is now most emphatically silenced; for the Silvertown Company, Hooper, Henley, and Siemens, have all satisfactorily asserted its suitability for such purposes.

I can imagine some of my readers thinking that my criticism on the weaknesses of india-rubber are somewhat severe, but I feel certain that the truest friends of india-rubber are those who will not conceal the unpleasant portion of its history.

There are now some thousands of miles of india-rubber cores in use, and although no cable can be referred to as working any great number of years, it can be confidently asserted that the interruptions due to faults, other than those arising from abraison, fouling of anchors, &c., will contrast most favourably with cables containing gutta-percha, notwithstanding the shorter time in which the manufacture of india-rubber cores has had to be developed. We may fairly ask ourselves, has the extended experience with gutta-percha, measured by its successes, disbarred all hope of its finding a competitor for the insulation of our deep sea cables?

The suitability of vulcanised rubber for submarine cables appeared eminently to advantage for warm climates, and our earlier experience was that in places where it was liable to exposure to the sun and weather, it showed a most satisfactory endurance both electrically and mechanically.

The cables and core made by Mr. Hooper for the India Government are considered monuments of success, for we must not overlook the important fact that experience had to be gained in the manufacture of india-rubber cores as with gutta-percha, and yet where decided and continued failures had to be recorded with the earlier gutta-percha cables, the very first length of india-rubber cable manufactured continues to work to this day. It is but fair to point out that the faults which were heard of some time since in the Persian Gulf india-rubber cable were not in any way due to a failure of the material. I do not hear such good accounts of the india-rubber cable laid between Ceylon and the mainland of India. This piece, I understand, is very much lower in insulation than when manufactured—in fact, its dielectric resistance is expressed by saying that it still works! I am, however, not able to confirm what has been said with respect to certain individual faults cut from this cable, although I believe them to arise from avoidable causes.

Now we must measure these facts not only as against our present knowledge of what has been done, or what india-rubber is capable of being brought to, but with the fact that attempts were made twice to maintain communication between Ceylon and the main land by means of gutta percha, both of which resulted in failure in about as many months as may be counted in years with the india-rubber core. In the manufacture of the Persian Gulf cable greater experience had been gained in manipulating gutta-percha, and the manufacture of the core and cable was conducted with all the skill and care available at the time; and yet the duplication of that cable, or rather a section of it, in a short time led to the significant introduction of the india-rubber core.

Whilst upon this part of the subject a few words may be said respecting a paragraph which appeared in this journal a few weeks ago, that the Western Brazilian Telegraph Company had handed over the repairing of the Para-Pernambuco section of their system to the Maintenance and Construction Company, and that 500 miles of gutta-percha was ordered for connecting the cable into Maranham, and for the purpose of repairing.

This is, I believe, the first time that an india-rubber cable has been handed over for repairing to the Construction Company; and without wishing to cast the slightest unkind insinuation, I cannot help saying that I think it would have been better if the repairing, even if gutta-percha had been admitted to be the thing required, were handed over to one of the firms who not only could undertake the repairing equally well, but having at the same time an affection for india-rubber, which would have prevented any unpleasant suspicion from arising in the minds of those who simply regard the Construction Company as pledged to the use of gutta-percha.

I can assert from personal knowledge that the Construction Company are not adverse to the use of india-rubber from any ill feeling or prejudice towards it as an insulator, but, as a matter of fact, any manufacturer would recommend the material most likely in his opinion to result in success, and from this we may gather that this company has not much confidence in india-rubber. This, however, seems to me a stronger reason why it would have been more in consonance with the interests of the Western and Brazilian Telegraph Company to have employed some firm to do this repairing whose experience is not unfavourable to either form of insulator. I may add that from all I can gather, any manufacturer who can select between gutta-percha and india-rubber for submarine cables invariably pronounces in favour of gutta-percha.

There are many applications, however, in which india-rubber so far surpasses gutta-percha that it could only be by affectation or indifference that we could possibly close our mind to the fact.

A writer in *Engineering* a short time ago, speaking of the Persian Gulf Cable containing an india-rubber core manufactured by Mr. Hooper, remarked that this core possessed so many excellent qualities in its earlier manufacture, which contrasted so oppositely to the cables referred to, that an inquiry appeared necessary to prevent its falling into disuse.

I quite endorse the remarks of this writer; and further, I am so far confident that there is nothing to justify any apprehension that it cannot be made equal to what it was in its earlier introduction, that I have not the slightest hesitation in saying that any manufacturer who directs his serious attention to the matter will find no insurmountable difficulties in his path.

In the year 1863, at the recommendation of the late Lieut.-Col. Stewart, the India Government obtained a length of the different forms of india-rubber insulated wire by different manufacturers, to compare experimentally and practically with gutta-percha for telegraph cables. A report was sent in to the India Office some time afterwards containing a communication from Mr. F. C. Webb, in which it was stated that in mere transit, and from being subjected to the ordinary treatment to which cables stowed on board ship are liable more or less, all the experimental lengths except one had so far deteriorated that some were utterly unfit for laying, although repeatedly cut up to ascertain whether any portion was sufficiently sound to make the test of submergence upon.

One of the lengths failed shortly after being laid, and only one behaved with such satisfaction as to admit of an unqualified report in its favour being made. This length was made by Mr. Hooper. There can be no doubt as to the very severe test which was imposed upon these cables, although Mr. F. C. Webb points out that it was no more severe than that to which the gutta-percha cable at the time on board was submitted to, in being occasionally wet and dry.

We know that this treatment for cables is most undesirable; and however well some of the cables may have come out of such an ordeal, we should not have been surprised if we could have been guided by recent experience to have been informed that they had all failed.

There is no doubt that the suggestion for practically testing india-rubber and gutta-percha under conditions which assimilate themselves to ordinary routine experience was highly commendable, and I would venture to assert might have led to more useful and profitable results than all the mass of evidence contained in the Report of the Committee on Telegraph Cables on india-rubber.

I cannot dismiss this portion of the subject without expressing my surprise that those manufacturers whose cables were pronounced upon so unfavourably in Mr. Webb's report, allowed the fairness or unsuitableness of the treatment to which they were submitted, to pass without raising the question.

However, the behaviour of the successful cable is a matter upon which we may congratulate ourselves, for it established a chance for the merits of india-rubber being heard, which perhaps might not otherwise have happened.

Space will not allow my going more fully into the inquiry which this report suggests, but it is certain that this form of insulated wire has not sustained that high character which was formed of it. This is due to an important departure from the details under which this experimental coil was made, and it seems to me surprising when we think of the acuteness and care which characterise all the specifications issued from the India Office for telegraph material, and considering the almost insurmountable difficulties of transporting this core to the Tropics without incurring serious deterioration, that this difference has not been pointed out by some one connected with the Department.

The lengths of india-rubber core manufactured on this principle by the Silvertown Company behave so satisfactorily, that the problem of reliable cores for submarine cables may be said to have received its solution.

I have no doubt that my readers will say that I have observed a reticence on the subject of these wires not being as durable as they were when made for experimenting; it is well known that these cores would bear exposure to the sun and weather without any alarming change; and I am certain that any one who experimented on the earlier manufacture must consider the science bestowed on this manufacture as being of a very low standard, to allow a core of such grand promise in its electrical and mechanical qualities to drop from the summit of excellence almost to the dead level of a failure.

The author can assert that no length of core or cable has been manufactured in the same way as this experimental cable since it became a commercial reality.

The author would have been only too well pleased to have omitted the mention of these facts, but in an article which professes to deal scientifically with this subject, it would appear extremely absurd to allow a phenomenon which any chemist interested in the subject could explain to pass as an insoluble and difficult task.

The sooner that electricans tack on a little chemistry to their general stock of knowledge the better, for it is certain that india-rubber insulated wire would have been saved from the serious odium which is now dawning upon it, had an adherence been insisted upon to manufacture upon the principles employed in the earlier stage of its history.

This fact is certain, that engineers and electricians have not acquainted themselves with that amount of knowledge respecting india-rubber which they have of gutta-percha, and if these short papers on the matter have in any way contributed to attract attention, or to incite the wholesome curiosity for inquiry which may tend to restore confidence in india-rubber, the author will feel sufficiently rewarded for his labours in this important field of inquiry.

In conclusion, india-rubber requires so much manipulating when applying it as an insulator, that the original character of the material affords no guide as to what we may expect in an insulated wire.

A RUSSIAN official return states that the revenue collected by the Russian telegraph service in 1876 was 5,669,350 roubles, as compared with 4,948,092 roubles in 1875. The figures for 1876 will be seen to present an augmentation of 14½ per cent. over those for 1875.

MOWBRAY'S "POWDER-KEG" BLASTING BATTERY.

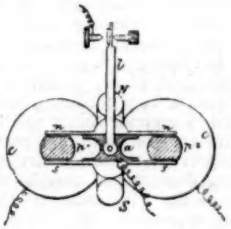
THIS electric machine for blasting purposes was patented in 1875 in Canada, the United States, and England. Several advantages are claimed for it over the ordinary machines—for example, the exciting surface is cylindrical, since, according to Hearder in the *Philosophical Magazine*, Vol. XV., p. 290, "cylinder machines have a superiority over plate machines of equal surface, in the proportion of four to one;" the reversal of the crank, by the operator under nervous excitement of firing, causes no damage; provision is made to absorb any moisture that may get within the case, so that time does not impair its efficiency if laid aside for some months. Its weight is only 20 lbs., or about two-thirds of the old battery with its cases. It is competent under every condition of atmosphere, whether damp, dense, or rarefied, to evolve at the will of the operator, a supply of electricity sufficient to fire fifty exploders. It is also claimed that, by the use of Mowbray's patent electric fuse exploders in connection with the blasting battery, fully twenty per cent. of the explosive may be economised—a considerable saving.

ELECTRICITY IN WAR.

THE *Globe* newspaper of August 23, says: "There are few of those scientific and practical discoveries usually numbered amongst the "blessings of peace" that have not been turned to account to intensify the effects of war. Steam, that quadruples trade by minimising distance and multiplying carrying power, also accelerates the speed of armies and augments the number and the force of destructive weapons, missiles, and engines. In like manner electricity, which annihilates space, not only gives wings to messages and counsels of peace, but brings into instantaneous communication the field of battle, the commander's tent, and the council-chamber where sovereign and ministers debate on policy, and condenses into weeks the consultations and the operations that, without this aid, would be the work of years. But this is only a small part of the duty which electricity seems destined to discharge in the wars of the future. It was thought only the other day that its most effective work would be the firing of submerged and invisible torpedoes, as far removed from the actual touch of those who should use them as from the knowledge of those for whose destruction they were to be employed. But electricity is as Protean as life itself; and its beneficent form of to-day is constantly found to neutralise its noxious form of yesterday. The fitness of the electric light to circumvent the torpedo has engaged the experimental efforts of military scientists for some time past; and, judging from what is known of the practice made on Monday night in the Medway, those efforts have led to a very appreciable success. The electric light apparatus which has been fitted up on board the new war-ship Téméraire was brought into play, and the effect was such that we are told no hostile vessel could have approached the illuminated ship within two miles without being seen. The results of the general adoption of this light, supposing it can be continuously relied upon, must go far to destroy the mysterious terror which at present surrounds the torpedo. Had the Téméraire been in the midst of foes on Monday night, it would not have been possible for a torpedo-boat or ship to come near enough to discharge a moving torpedo without herself becoming a conspicuous mark for the Téméraire's guns. Add to this the use of the light in revealing stationary torpedoes planted under the sea, and we may safely congratulate ourselves upon our command over this manifestation of the electric force."

THEILER'S PATENT RELAY.

THE peculiarity of this Relay consists in the novel construction of its magnetic armature and its combination with an electro-magnet, whereby the power is thoroughly utilised.



The figure gives in plan an outline drawing of the relay. It consists of an ordinary electro-magnet *c c*, of which p_1 p_2, are the poles. Two light tongues or bars *n n*, and *s s*, of soft iron are mounted on a pivotted axle at *a*, their flat sides facing each other, and kept a certain distance apart by a short piece of brass, shown in the figure by the dark shading. The armature in fact somewhat resembles a double tuning fork.

This armature is magnetised by a horseshoe permanent steel magnet, whose poles N and S, are shown in the figure. These poles are in close proximity to the portions of the tongues *n n*, and *s s*, which, at the middle of their length, are made to project.

The magnet poles impart similar polarity to the ends of the tongues, to which they are respectively in close proximity to; consequently, when the electro-magnet becomes magnetised by a current, the whole armature tends to turn on the axis at *a*.

Fixed to the armature is a brass tongue *l*, which is furnished at its extremity with the usual platinum contact point playing between an insulated and a contact screw.

This Relay is found to give very good results, especially for fast speed working.

Review.

A Practical Treatise on Lightning Protection. By HENRY W. SPANG. (Spon & Co., London; Claxton, Reinson, and Haffelfinger, Philadelphia, U.S. America.)

ALTHOUGH very considerable public interest is excited every time any damage is done by lightning, and frequent discussions on the effective way of protecting buildings from the destructive effects of lightning discharge have taken place in the daily papers and elsewhere, the practical knowledge of the subject has, we believe, never been embodied in a book form. Mr. Spang's work, dealing as it does exclusively with the subject of lightning protectors, will therefore prove very useful, especially as it contains much practical information.

The first fifty pages or so, deal chiefly with the phenomena of thunderstorms, and form a good introduction to the more practical matter.

In the following portion of the book the proper way of putting up the protectors, the metal of which they should be composed, their form, &c., are discussed, and the defective way in which many buildings are protected is drawn attention to.

In one or two cases Mr. Spang disagrees with, what are generally considered to be *points* of great importance in lightning conductors; thus, in the chapter on "The air terminals of a lightning conductor," Mr. Spang says:—"The point need not be tipped with gold, silver, platinum, or copper, in order to prevent it from becoming coated with rust, as it is absurd to suppose that a small thickness of rust upon the end, or any other part of the conductor, will prevent the electricity of the clouds from alighting thereon and uniting with the electricity of the earth." We must say that we cannot agree to this reasoning. Mr. Spang admits that lightning follows the path of least resistance, but a conductor coated with rust can hardly be considered as having a low resistance, and the lightning will have to penetrate this rust before it can reach the metal and thereby find earth. It may chance that a nearer passage for the discharge will be found under these conditions through the damp stonework, &c., of the building to which the protector is attached.

With regard to the air-terminal of the conductor being required to be pointed, we think Mr. Spang rightly says:—"The ordinary end of a rod is blunt when used in connection with the ball of a leyden jar, but when applied to the lower state of electrified air, or to a thunder-cloud which extends over many thousand acres, it becomes a point, and will bear about the same relation to the electrified air or thunder-cloud, as the sharp point of a needle does to the hand of an adult." Arguing from this he says:—"There is no necessity for employing points at intervals along a conductor as has been employed upon a number of conductors."

WITH a telephone and a wife a man ought to hear all that's going on.—*Danbury News.*

Notes.

IT is a well-authenticated fact that certain flowers, such as marigolds, sunflowers, and poppies, have been seen at rare moments to emit little flashes of light. The best time of the year for observing the phenomenon is during July or August, the hottest months; the best time of day, after sunset or before sunrise, and the best weather during drought. The fact that the light is never seen after rain, or while the air is laden with vapours, and that it is always most brilliant before a thunderstorm, support the conjecture that it is an inductive effect of atmospheric electricity.

Apropos of Mr. Preece's lectures on the Electric Telegraph and the Telephone at the recent meeting of the British Association at Plymouth, and the experiments with the articulating telephone, its "crowning marvel," it is interesting to remark that the last time the Association met at that place in 1841 under the presidency of Dr. Whewell, the telegraph was little better than a promising experiment, and the first submarine cable, that between Dover and Calais, was not laid till nearly ten years after.

IT is said that in the dry atmosphere of the elevated plateaux of the Sierra Nevada and Rocky Mountains the human body becomes highly charged with electricity; and two serious accidental explosions which took place recently are attributed to this cause. At the entrance of a tunnel which is being excavated in the Washoe Range, Mr. Henry L. Foreman, formerly an officer of the telegraph service at Washington, was handling some of the fuses used in blasting, when suddenly they exploded, blinding him and otherwise seriously injuring him. They were large fuses, an inch long, and charged with fulminate of mercury. A few weeks later Mr. Thomas Coombs was engaged in picking up several of these fuses, when they exploded without any warning, mutilating his hand and forearm, so that it had to be amputated. These singular mishaps led Mr. Sutro, the manager of the tunnel, to experiment in order to find out the cause of them. He surmised that the electricity of the body had fired the fuses, and succeeded himself in firing a number of fuses by contact of his hands with wires leading to them. To prevent further accidents the men working in the tunnel are provided with non-conducting shoes, and other precautions are taken.

THE Sazarac Lying Club's meetings are reported in the Austin (Nevada) *Reveille*. The members are very able liars, according to what we read about them. One of them stood up in a recent meeting and said: "The telegraph company are now using the quadruplex system over the Virginia and Salt Lake circuit, by means of which four messages may be sent simultaneously over a single wire. The increased strain on the wire is not visible here in Austin, but I was out at Dry Creek yesterday, and in that vicinity

the wire was just humping itself, and groaning and straining, and dropping words off in chuncks. I examined the wire and found a knot in it, and came to the conclusion that a quadruplex message had struck the knot and got tangled up, and stuck at that point. I tried to straighten the wire out, but the account of a battle between the Turks and Russians struck me on the ear and knocked me down, and I concluded that it was not advisable to fool with the thing."—*Journal of the Telegraph.*

THE overhead wire recently erected between the Canterbury Hall and the Queen's Theatre, for the purpose of exhibiting to nightly audiences Varley's telephone transmitting musical notes, spans the Thames at a single swing of five hundred yards. On one side of the river the pole supporting this great stretch of wire was planted on the garret-roof of a worthy cobbler. The vibrations set up in the wire by the wind are loud and musical, and the cobbler is of opinion that he hears the telephone a great deal better than those who pay to hear it; but he begins to think the music a trifle monotonous in its character.

Apropos of the electric light, they have fitted up twelve electric lamps at the Lyons railway station, and twelve more will be added forthwith. These twenty-four lamps will be fed by a single machine. It is believed that twenty-two horse power will yield a light equivalent to 2,400 gas lamps, each lamp burning 100 litres of gas per hour.

THE electric light apparatus with which H.M.S. *Alexandra* has been provided, and which is designed for the detection of torpedo boats, has been fitted at a cost of £1000. The electric lamp is fixed on the foremast.

A GREAT thunderstorm raged over the Midlands on Thursday, the 16th ult. Reports from Sheffield, North Derbyshire, and Nottingham, describe the lightning as having been remarkably vivid, and the rainfall very heavy in the afternoon. At Nottingham rain and hail fell in torrents. Four boys, whose ages range from seven to eleven years, were playing in a public promenade known as Robin Hood's Chase, when the storm came on. They took shelter under a tree, which was soon after struck by lightning, and they were all dreadfully burned, one of them not being expected to recover. A woman named Keys was sitting in a house in Ford Street, when the lightning struck the chimney, descended the flue, knocking her over and burning her arms. Other houses were struck in different parts of the town, and the standing corn has been seriously damaged. It was a short, sharp storm lasting only ten minutes. Further to the south, at Stafford, Cambridge, and Nuneaton, a terrific thunderstorm is reported to have occurred in the evening. At Stafford the lightning struck the belfry of a school, and knocked it through the roof into the school-room underneath. In Warwickshire the storm lasted nearly an hour, the lightning was strikingly vivid, the thunder loud and continuous, and the rain very heavy.

IN the *Philadelphia Magazine* for August there is a short but interesting account of a case of lightning stroke which occurred during a very violent rain and thunder storm, in the neighbourhood of Calcutta, in 1871, during the south-west monsoons. A tree overhanging a telegraph line near the European Military Hospital was struck, and the discharge passed from the tree to the four wires of the line, which were about a foot from it, then escaped to earth through the iron standards on which the wires were supported, breaking in its passage fourteen double-cap porcelain insulators. Nothing unusual was observed at the terminal stations of the wires. The writer (Mr. R. S. Brough) points out that the lightning broke these insulators, although each had an electrical resistance of, probably, several thousand megohms, in preference to traversing the line wire, whose resistance could not be more than 500 ohms, to earth through the receiving instrument at the nearest station. "Writers," says Mr. Brough, "appear to overlook the fact (experimentally illustrated long ago by Faraday), that there is exerted a mechanical stress proportional to the square of the potential, tending to produce descriptive discharge. Thus the discharge may occur either along a path of mininum mechanical resistance, or along a path of mininum electrical resistance. Which form of discharge will occur in any particular instance, depends of course on the special circumstances of the case; but, generally speaking, as the potential increases, the tendency naturally is *cæteris paribus*, for the disruptive to predominate over the conductive. In the case of lightning the potential is so great, that, for any form of 'lightning protector' to be efficient, the conductive facilities offered must be correspondingly great—that is, the protector must offer no sensible resistance to earth, otherwise a descriptive discharge may take place from the protector itself, which under those circumstances becomes merely a source of danger." From a consideration of the energy of the discharge employed in breaking the insulators, the author adduces the potential of the lightning to have been 216,810 volts, which would give (assuming that the sparking distance increases in proportion to the square of the potential, and taking into account the fact that 1000 of Mr. Warren De la Rue's rod-chloride and silver cells give a spark of 0·009166 inch in length), a spark in air between two electrodes 36 feet apart.

AN account reaches us from Toronto, Canada, of the death, by lightning, of Bassielle Crevair, a French-Canadian, employed as a telegraph lineman. He and another man were at work on the line last July when a thunder-storm came on. They continued working, and Crevair was in the act of reaching up to prune some branches from a tree over the line by means of tree shears, when he was struck and fell. On recovering consciousness he spoke once, but was then unable to speak, or move, or close his eyes, which remained wide open. He died soon after. The shears he used were mounted on a pole, and had a wire attached to one of the blades,

which was pulled by hand in the act of cutting. His fellow workman stood only about two feet away, and was blinded by the flash.

EXPERIMENTS are being made to determine the fitness and economy of wrought iron telegraph poles on the Berlin-Königs-Weisterhausen line, along the Görlizer Railway. The poles are formed of double ⊤ irons, and are inserted into granite bases built on the ground. The insulators are fastened to iron cross-pieces.—*D. A. Polytech, Ztg.*

DURING 1875 the number of telegrams sent in Switzerland amounted to 77 per cent. of the entire population, in England to 58 per cent., in Belgium 36 per cent., in Norway 27, in Denmark 22, in France 19, in Germany 19, in Austro-Hungary 12, and in Russia 4 per cent.—*Moniteur Indust. Belge.*

WE learn from the *Bullettino Telegrafico* that the duplex system, with Morse receiving instruments, is now at work between Milan and Brescia; and also that Professor Fleeming Jenkin's *Electricity and Magnetism* has been translated into Italian by Signor Lamberto Cappanera, Vice-Secretary to the Director-General of Telegraphs.

PROFESSORS PERRY and AYRTON, of the Imperial College of Engineering, Japan, have undertaken an investigation into the specific inductive capacity of gases at different pressures, and have communicated their first results to the Asiatic Society of Japan. The authors point out that it was formerly supposed that because a gas offered less and less resistance to the passage of an electric spark as its density was diminished, therefore a very rare gas would offer an extremely small resistance, and that the invention of the Sprengel pump had shown this conclusion to be erroneous. With respect to the specific inductive capacity of gases, Faraday had, after careful experiments, come to the conclusion that it was constant for all gases at all pressures; and it occurred to the authors to test the truth of this conclusion by means of the Sprengel pump, which was not invented in Faraday's day. Their results are as follows:—

Substance.	Spec. Ind. Capacity.	Remarks.
Air	1·0000	Taken as standard.
Vacuum	0·9985	The vacuum was always less in sp. ind. cap. than air, even in single observations.
Carbonic dioxide ...	1·0008	When air was allowed to mix with this gas, the sp. ind. cap. more and more approached 1·0000.
Hydrogen	0·9998	
Coal gas...	1·0004	
Sulphuric dioxide ...	1·0037	

"Thus there seems to be a connection between condensability, diffusivity, viscosity, high index of refraction, and specific inductive capacity of a gas."

THE amount of telegraphic wire and apparatus exported last year was £924,985: last year, in the seven months, £324,712.

ON the 29th of last month a fire occurred at the New York office of the Western Union Telegraph Company, U.S. The cause of the fire was due to the sparks jumping from one wire to another in the test box, owing to the high battery employed to work some of the currents.

THE electric-light apparatus on board the Téméraire and the Alexandra having proved a valuable acquisition to those vessels, the Admiralty has directed the contractors to put similar apparatus on board the armour-plated turret-ship Dreadnought, which is now fitting for sea at Portsmouth. It is likely that other vessels will be fitted in a similar manner.

IN a recent number of the *Comptes Rendus*, of the Paris Academy, M. Donati Thomasi publishes the fact that when a current of steam is sent, under a pressure of from five to six atmospheres through a copper tube of from two to three mm. diameter, wound spirally around an iron cylinder, the latter becomes so strongly magnetic that an iron needle placed some centimetres away from it is energetically attracted, and remains magnetised during the whole time the steam current passes through the tube.

M. THOMASI has just described to the French Physical Society a new and delicate relay of his invention, applicable to long submarine cables. It is reported that he has worked it through a resistance equal to 2,500 miles of Atlantic cable with five per cent. of the current from a Menotti cell.

IN a recent number of the *Hamburger Garten-und-Blumenzeitung*, Herr Levy describes a plant, called the *phytolacca electrica*, possessing strong magnetic properties. On breaking off a twig it is said that a sensation is felt like the shock of a Rhumkorf coil. At seven or eight paces off a small compass is visibly affected, and violently so on approaching it very near. The revolution of the needle is reversed on withdrawing it. The strength of the magnetic effect is said to vary with the time of day. During the night it is almost zero, and attains its maximum at 2 p.m. When the weather is stormy the effect is increased, and when it rains the plant appears to wither. Herr Levy says he never saw any insects or birds about the plant; and that there is no trace of iron or other strong magnetic metal in the soil.

AT a meeting of the Russian Physical Society, held recently, M. Tchicaleff gave an account of his experiments on the intensity of the electric light in the open air. Altenec's magneto-electric machines were used. The eye could not detect much difference in the lights of two machines, one equivalent to ten thousand candles, the other to four thousand, although in the first case a refractor was used, and in the second a reflector. During these experiments the advantage of carbon points, covered with galvanic copper, was again proved; ordinary carbons fusing for a length of 0·07 metre, while the copper-covered carbons burned for a length of 0·01 metre.

M. LIPPMANN has (July 16th) communicated another paper to the Paris Academy of Science on the electric and capillary properties of mercury in contact with different aqueous solutions. When mercury is in contact with water, pure or acidulated, the addition of a small quantity of certain substances to the water changes notably the capillary constant, and the electro-motive force. M. Lippmann proves that for each value of the electro-motive force the capillary constant has one, and only one, determinate value, which is independent of the chemical composition of the liquid. That is to say, if for two different combinations of mercury and liquid, the electro-motive force is the the same, the capillary constant will also be the same.

City Notes.

Old Broad Street, August 31, 1877.

UP to the present time we have not heard that the directors of the United States Cable Company have received a reply to their "satisfactory explanations" to the American Government. But it is interesting to note the tone assumed by the directors in their circular as contrasted with the bold declaration of Viscount Monck and the frothy utterances of Mr. Cyrus Field. Lord Monck asserted the ability of the Anglo-American Company to put a stop to any interference on the part of the American Government. Mr. Field, whose native air is exaggeration, audaciously averred that his Government never will and never can interfere with the Direct Company or its cable. In their recently-published circular, the directors of the Direct Company cautiously express their incredulity that "the Government of America would, under any circumstances, drive from their shores a cable, without which there would virtually exist but one company to carry on the great traffic between the two companies." It is obvious that while Viscount Monck disdains to be a slave to any sort of apprehension, and Mr. Cyrus Field gives vent to characteristic braggadocio, the directors of the Direct Company are certainly not untroubled by the message which has been transmitted to the American minister in London. We do not hesitate to say that the hopes to which apparently they cling are devoid of a solid basis. They proceed on the assumption that it is impossible to establish another cable company. We candidly confess that if it were impossible that a new company could be formed, the American Government would be foolish indeed to insist upon the removal of the Direct Cable from its shores. But the formation of a cable company, though more than a day's task, is comparatively an easy matter. With a capital not exceeding two millions and a half, a new enterprise could make an excellent start. The enormous capital of the amalgamated companies manifestly renders the payment of a fair dividend a hard job.

It has been fully proclaimed that the number of messages despatched by the Anglo-American and Direct Companies has not decreased since the rate was raised. But it is easy to make the statement. Besides, the guiding spirits of the two companies are, at any rate, unable to prove that the number of their messages would not have materially increased if the lower rate had been adhered to. We infer that the practice of telegraphing to America will every year become more popular. Anyhow, a monopoly will not be endured. It is sheer folly to maintain that the high rate now charged must be persisted in because it pays better than a lower one. The moment a company charging a lower rate enters the field, it will inevitably do the most business. A high rate might, we have pointed out before, be wise policy if competition were an impossibility. As it is, competition is actually invited, and it will assuredly not refuse to accept the invitation. There are rumours afloat that a new company is already being formed by certain American capitalists, and a report has really reached England that the shilling rate will be adopted by them. The leading journal refers to the "clever policy" which annihilated competition for the telegraph business between England and the United States. So in a sense it was, no doubt, clever. But there is such a thing as being too clever by half. Vaulting ambition does o'erleap itself. Attempts to secure success at the expense of other people are over and over again defeated. We do not think it at all probable that competition between the two countries would be annihilated even if the two companies instantly put a reduced rate in force. The annihilation of competition is not a trifle. But the evil hour might have been indefinitely delayed. Our opinion from the present mistake is that it is now rapidly arriving. When it does arrive, Mr. Pender's fabric will come down, and great will be the fall.

Poor Mr. Abbott is compelled to admit that there is something wrong even about the West India and Panama Company. We can quite understand, and even sympathise, with his disappointment. After all his trumpet-blowing it must be a bitter pill to him that the directors "have not seen fit" to pay the full six months' dividend upon the preference shares on the 30th of June. There are ill-natured persons who have not the faith of Mr. Abbott, and who substitute for the "have not seen fit," "were not able." But they are clearly wrong. We have it on Mr. Abbott's authority that the company has actually earned the dividend. Therefore, as Mr. Abbott, speedily recovering his confidence in the company, points out, if the directors err "in this matter of accelerating a dividend"—should it not be in not accelerating a dividend?—they can claim absolution on the plea of caution. Moreover, since Mr. Abbott has persuaded himself that regrets are useless, he declares that the delay in the dividend is only a question of consequence to the speculator; to the real investor it is immaterial whether a dividend is forthcoming three months behind its time. We fear there exist individuals—some of them may be shareholders of the West India and Panama Company—who are not willing to accept Mr. Abbott's ruling. They prefer not to wait for money, especially when it is believed to have been fully earned. We can, however, believe that the fall in the price of West India and Panama shares has given "a fresh opportunity to investors," although we have not heard that the opportunity has been seized with the proper amount of enthusiasm.

Of course Mr. Abbott does not conclude his circular without once more recommending his friends to repose practical confidence in the stability of the Telegraph and Construction Maintenance Company. There is, it is true, no reason to imagine that the company is anything but sound; it is doing a large business, and must, as Mr. Abbott urges, continue to do it. But there would be no less faith in the stability of the concern if Mr. Abbott and certain other persons ceased to insist so loudly and so frequently upon the transcendent advantages it offers to its shareholders. It has over and over again happened that loudly praised enterprises come to grief. We have no idea

of the kind about the Telegraph and Construction Maintenance Company. But Mr. Abbott sends his circulars broadcast to the ignorant as well as to the informed.

The contention of Sir James Carmichael that the half-yearly report of the Submarine Telegraph Company is a satisfactory document can hardly be denied. Seventeen and a half per cent. is, as dividends go, pleasant to think of, and still more pleasant to participate in. Moreover, we confess we cannot see that the shareholders of the Submarine Telegraph Company have any reason to suppose that next half-year they will have to be content with a dividend at a lower rate. If things go on as they are really justified in anticipating, the rate may be again increased.

We learn from the report of the Mediterranean Extension Telegraph Company that the receipts for messages during the half year were £2,384. The shareholders would no doubt have been better pleased if the amount had been larger. But how comes it that in order to earn less than £2,400 nearly £1,800 were expended? Although the affair is not one of great magnitude, there must surely have been extravagance in the management. When we compare the receipts with the expenses, we do not wonder that the dividend of the company did not exceed three per cent. A small company which spends £14 to earn £20 is not a model of joint stock enterprise.

The shareholders of the Great Eastern Railway Company may be congratulated upon the fact that Sir Edward Watkin has consented to retain his position as a director of the company. We are not blind admirers of the honourable member for Hythe. He has possibly as many faults as most men. But there is no doubt that his presence at the board of the Great Eastern Company has a beneficial influence upon his colleagues. He may be too fond of giving the rein to a native spirit of enterprise; they are too willing to be content with things as they are. It is to be feared that the directors of the Great Northern Company will decline to re-open negociations with the Great Eastern Board. If, however, Sir Edward Watkin can induce them to do so, he will entitle himself to the gratitude of the entire body of shareholders, whether they think it or not.

There is little in the Great Western report to call for remark. The dividend is 3½ per cent., and the gross increase in the receipts for the half-year £39,907. It is stated that no exact comparison can be made, because the working of the Bristol and Exeter lines for seven months was included in the report to July 31, 1876. The Great Western is, on the whole, one of the best managed companies existing.

After what has always seemed to us to be unnecessary delay, it has at length been decided by the shareholders of the District Railway Company that the time for completing what is known as the inner circle has arrived. We are not quite able to share the sanguine anticipations of Mr. Forbes respecting the financial result; but it is reasonable to expect that the extension of the system will be profitable to the company, though not so profitable as the bit of line between Victoria and Sloane Square. There is a deal of talk about a new railway to connect Oxford Street and Regent Street with the termini of the principal companies, and such a railway is, in fact, one of the great wants of the metropolis. But why on earth should it be left to a new company to undertake the enterprise? If the directors of the Metropolitan and District Companies allow such a splendid opportunity for increasing the value of their properties to pass by they deserve to lose the confidence of their shareholders. The idea ought to have been acted upon long since. That the Marble Arch and Regent Circus are not accessible by rail is one of the puzzles that few foreigners, at least, can understand.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—I trust you will allow me space in the next issue of your valuable journal to finally reply to the statements contained in M. Clamond's second letter.

The lecture to which M. Clamond refers at the beginning of his letter was probably the one I read in March, 1875, before a provincial scientific society, on thermo-electricity, in the course of which I showed and explained his pile; but as to eulogising him, or claiming honour for my father, I never even thought of doing either the one or the other. I have just read through that portion of the paper referring to M. Clamond, and I find that not even the name of the late company is mentioned.

In the next paragraph of M. Clamond's letter there is not the slightest particle of truth, for the articles on and notices of our thermo-pile which you inserted in your journal were, as you are aware, not written by us; and, with the exception of one of them, we had no idea that they were going to be published.

M. Clamond says he does not heat his positives in the moulds. It is of very little consequence whether they are heated in them or placed in them just before casting, as the tin would be oxidised precisely the same, for it is impossible to put thin tin plate in contact with heavy iron moulds heated to dull redness without almost instantly oxidising its surface.

The next part of M. Clamond's letter I will answer fully later on, merely remarking here that although ribbed discs are mentioned in his first patent, yet they were simply for the purpose of keeping the bars from lateral movement, and were not fitted or intended to bear the weight of the layers of bars above them.

With regard to the long positives—as we have stated from the beginning, our object in using them is to gain mechanical strength, and the gain in this direction far more than compensates for the slight loss in electro-motive force. In one series of experiments the long positives showed an increase of strength equal to 39 per cent.

Messrs. Clark, Ford & Co. have, in a report which will be found at the end of this letter, given some further results obtained with the composite pile of short and long positives. It will be noticed that the weight of copper deposited by the latter in the twenty-two hours' test is only 2·7 per cent. less than that deposited by the short.

M. Clamond, in an unguarded moment, has published a certificate from M. Rousselon, according to which, in June or July of 1875, he is said to have fitted fire-clay cylinders inside his piles at M. Goupil & Co.'s works, and says the certificate: "M. Clamond's thermo-electric piles have since that time rendered constant and regular service."

The inference to be drawn from this is—firstly, that prior to the fitting of the cylinders the piles did *not* "render constant and regular service," and, secondly, that M. Clamond permitted the late company to come to grief through the fusing of his piles, while he knew all the time how to make them "render constant and regular service."

I know as a positive fact that M. Clamond did not tell the board of directors anything about these inside

cylinders, although at that very time—that is, June or July of 1875—the late company were having piles sent back to them literally by dozens—all fused; and yet M. Clamond said nothing. It is true that about this time M. Clamond's brother *invented*, and tried to induce the company to remunerate him for, Colonel Baker's Method of Heating (patent No. 1718; 27th June, 1866); but even this did not very materially lengthen the period during which the piles worked.

I will now proceed to show that M. Clamond *does* "belong to that category of people who do not hesitate to appropriate to themselves the ideas of others by patenting them, even when they have good evidence that they do not belong to them;" and to do this it is simply necessary to run through his two patents. The first patent (Mure & Clamond, No. 3060, Oct. 7th, 1868) says: "This invention relates to a thermo-electrical pile in which a new substance called 'galena' (pure potter's ore, without either silver or copper), is used for generating electricity by heat, the said substance galena being combined with iron by means of a solder specially adapted for the purpose."

The thermo-electric properties of this *new substance* were investigated by Prof. Cumming more than forty years ago. See his *Manual of Electrodynamics*, also 4th edition of *Brandes' Chemistry*, page 302, published 1836.

M. Clamond adopted this absurd couple, I suppose, because in the old lists of thermo-electric elements they are placed a considerable way apart, without thinking of the thermo-electric lines of the two substances, or of the fact known to every tyro in chemistry—that galena is decomposed when heated in the presence of iron.

These bars which were certainly "made against all the known and admitted laws" both of chemistry and electricity, are to be built up in circular layers around a Bunsen gas-burner, "and separated by intermediate rings of cardboard impregnated with silicate of soda to render them uninflammable."

In the first part of the patent, rings are also spoken of, made of refractory earth, having "rectangular ribs projecting from" their surfaces and radiating from their centres, with the object and for the purpose of keeping the bars "in their proper position on the disc of refractory earth."

In a patent taken out nearly a year and a half before Mure and Clamond's, Colonel Baker says (No. 1314, 1867): "I place successive rows of like kind so as to form numerous layers of bars, each layer being insulated by earthenware plates or suitable material." And in Patent No. 1135, 1866, he says: "A cylindrical stove of any required dimensions is surrounded in a stella form by pairs of thermo-electric metals placed in circular layers one above the other, and as close to each other as possible consistent with insulation; the inner ends of the pairs in each circular layer to approach near to the cylindrical stove but not to touch it."

In M. Clamond's second patent (No. 1199, 1874) he claims "sealing" or fitting the couples together, casting in moulds "heated almost to the point of fusion of the thermo-electric material," "heating thermo-electric piles by gas," and the employment of my circular thermo-electric piles, &c.

The two first claims we have dealt with in a previous letter, and the two last are simply a repetition of the second claim in Mure & Clamond's patent, therefore I need not make any further remarks on them, except to point out that the coke or charcoal pile described and shown is identical with the one Col. Baker patented in 1866, or eight years before M. Clamond took out his patent. To let readers compare the two, I will, with your permission, copy the description as it appears in the patent:—"This combustible (coke) is enclosed in a column of cast iron or of ordinary iron C, concentric to the pile, and of a diameter sufficiently narrow to preserve an annular space, B, for the radiation of the heat. The coke rests upon a bar or grate, G, which admits sufficient air for the combustion."

The two extracts speak for themselves, and comment on my part is quite needless.

As to the Bunsen burner used by Clamond, he is no more the inventor of it than he is the inventor of gunpowder, as they can be bought ready made at any chemical apparatus seller; and there was a "thermo-pile (Nöe's system) with twenty elements in radiating arrangement heated by gas" (Cat. No. 1299) exhibited by P. Dörffel at the Loan Collection of Scientific Apparatus, in which one of these perforated burners was employed.

Yours faithfully,
E. WRAY, Jun.

London, August 9th, 1877.

"7, Pope's Head Alley, Lombard Street,
"19th July, 1877.

"DEAR SIRS,—We have made further experiments with your thermo-pile, upon which we reported on the 9th June last, and now make you acquainted with the results.

"The pile, more fully described in our former letter, consists of two series, the one being composed of bars with 'long positives,' the other with 'short positives,' the two series being quite symetrically disposed around the source of heat. Each series originally consisted of 18 elements, now reduced to 17 by our breaking up one element in order to examine and be enabled to report upon the construction from our own knowledge.

"The object of the following experiments was to ascertain that the pile might be left for a considerable time without attention, and that its action did not sensibly diminish by prolonged heating. With this view each series was joined up with a pair of copper plates, four inches in diameter and one inch apart, immersed in an acid solution of copper sulphate. In the first experiment the electrolysis was continued for 22 hours, when it was found that the weight of reduced copper was—with L, 626 grains, = 28·45 grains per hour; with S, 644 grains, = 29·27 grains per hour, in which the letters L and S respectively stand for the words series with long and series with short positives.

"The electro-motive force of the series before and after the above experiments was in volts:

Series.	Before.	After.
L	1·096	1·053
S	1·179	1·129

Without extinguishing the gas the pile was then left unconnected for 24 hours, when it was joined up again with two decomposition cells similar to those described above, and in this case the action was allowed to go on undisturbed for eight days. At the end of this time the weight of the reduced copper was found to be—with L, 4,733 grains, = 24·65 grains per hour; with S, 4,466 grains, = 23·26 grains per hour.

"The electro-motive force before and after electrolysis was in volts:

Series.	Before.	After.
L	1·110	1·101
S	1·188	1·171

We are unable to account for the fact that during the eight days' test the reduction of copper was less in S than in L, as during the 22 hours' observation the reverse was the case. We think, however, that it must

have been due to a bad contact at one of the terminals, as no sensible alteration in the relative electro-motive force of the two series occurred.

"We consider the above results, on the whole, to be very satisfactory, as proving that the thermo-pile may be left for a considerable time without any attention.

"We are, dear sirs, yours faithfully,

"CLARK, FORDE, & Co.

"Cecil and Leonard Wray, Esqrs."

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—It has often come under my observation that, although the mirror apparatus for cable signalling is capable of being worked with a far greater speed on long submarine cables than Sir William Thomson's Siphon Recorder, yet the latter apparatus is nearly always preferred on account of the greater facility for checking errors, &c. I think that the generality of cable clerks prefer "mirror" to "recorder" working, as it is much less tiring and so little delay is caused, if any at all.

Now, if while working a mirror, the signals could be duly recorded by means of a Siphon Recorder, would not a great advantage be gained? All the messages could be checked from the recorded signals, and the speed of working would be materially increased.

Could not the signalling coil which moves the siphon of the recorder be in circuit with the secondary coil of an induction-coil? the primary coil of which would be in circuit with the mirror apparatus in connection with the cable, and through which, of course, the current or charge, as the case may be, transmitted from the distant station, would pass.

The *primary* coil would be of low resistance, so it would not make any material difference in the total resistance of the circuit.

The *secondary* coil would be formed of a great number of turns of fine wire, and could be provided with a shunt, supposing the induced current should be too strong. Or, instead of employing a shunt, the primary coil could be made moveable, so that its sliding in or out of the secondary coil could produce an increase or diminution of induced current.

But there is, apparently, one great drawback to this plan, namely, the "kick" of the siphon, produced by the secondary induced current, so to speak, which traverses the secondary coil directly the battery current ceases to flow through the primary coil. For, by Lenz's law, "An inducing current at the moment it ceases produces a direct current"; *i.e.*, a current in the opposite direction to the first induced current, but in the same direction as the inducing one. So that, according to this, supposing the letter e, which consists of one "dot," was signalled from the distant station, it would be recorded like the letter a, which consists of one "dot" and one "dash." And again, there is another disadvantage arising from the "retardation" caused by self-induction in the primary coil.

This last effect is mentioned by Mr. G. K. Winter, F.R.A.S., in his paper on the "Use of Electro-magnetic Induction in Cable Signalling," which appeared in your Journal of September 15th, 1874. In the same paper he mentions a plan of his in which an induction coil is placed at the extremity of a cable from which the current passes through the primary coil, the secondary coil, in circuit with mirror apparatus, being traversed by the induced current.

Now is not this plan somewhat analogous to the one I have mentioned? Mr. Winter describes a method for eliminating the "magnetic retardation" in the induction coil, using as he does an iron core, but he does not mention anything concerning the return current which traverses the secondary coil when the primary circuit is broken.

I have not been able to obtain any of Mr. Winter's previous papers on the subject.

But to return to the subject in hand. The question is whether, in quick signalling, the "kick" before mentioned would be sufficient to render the recorded signals indistinct enough to be unreadable, or whether the siphon would merely return to the "zero" line ready to be influenced by the next current.

I should be exceedingly obliged for some information on this subject, as I have no opportunities for experimenting, and I should also like to know whether this idea is of any use. Everything has a humble beginning, so you will look leniently on any errors you may detect in my technical expressions.

I am, Sir, yours truly,

L. R. B.

[THE suggestion of our correspondent is, we believe, new, but it is not very clear what he hopes to gain by such an arrangement. Apparently, his object is to work a siphon recorder in addition to a mirror instrument, without introducing any extra resistance into the circuit. But to do this, as he states, the primary coil of the induction coil would have to be of a low resistance; this being the case, so far from requiring a shunt to reduce the strength of the secondary current, he will find that the latter would be almost, if not quite, imperceptible with no shunt, if the weak currents with which cables are worked are employed. If the currents are strong enough to work the induction coil they may just as well be sent straight through the coil of the siphon instrument without the intervention of the former. It is quite a mistake to suppose that the employment of an induction coil can increase the strength of a weak current.

Mr. Winter's plan is only analogous to that of our correspondent in that he employs an induction coil with the primary in circuit with the cable, and the secondary in circuit with the instrument. His object in using such an arrangement is quite different; it is to obtain quickness and sharpness of signalling.

We believe the "kick" with such an arrangement would cause no more difficulty than that experienced from the ordinary discharge which takes place from a cable, but perhaps some of our subscribers can give us further information on this subject, gathered from their experience. ED. T. J.]

THE first telegraph line in China is now in operation. It is six miles in length, and has been erected by Li Hung Chang, Viceroy of China, from his official residence to the Tietsen arsenal. There has been no attempt at interference by the native populace, as in the case of telegraphs projected by foreigners. Several lines are contemplated in Formosa by the Governor of that island.

To Correspondents.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which THE TELEGRAPHIC JOURNAL is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the EDITOR; business communications to the MANAGER, 10, Paternoster Row, E.C.